Abstract

In cellular networks, the Call Admission Control (CAC) limits the number of call connections into the network in order to guarantee connection level Quality of Service (QoS) parameters such as new call blocking probability and handoff call blocking probability. Velocity, direction, distance of travel and class of the call (voice or data) of a mobile user also affects call admission decision for that call. While admitting calls to a cell, if information about ongoing calls in the neighbouring cells is available, then the cell can derive the impact of neighbouring calls, on its own call admission and perform resource allocation for handoff calls in advance. This reduces the handoff call dropping probability. Also in case of congestion or QoS degradation, channels are borrowed from the neighboring cells depending on their ongoing call status. This exchange of traffic information requires neighbouring cells to interact with each other in cooperative manner.

A Multi Agent System (MAS) comprises of a set of agents, which interact, collaborate, cooperate, or even negotiate with each other and with the environment to solve a particular problem in a coordinated manner.

The work presented in the thesis contributes by demonstrating the ability of MAS in improving or maintaining the quality of service to meet the required connection level QoS by the network provider for cellular networks. This is achieved through agent interaction, for various call admission control strategies for different traffic classes. It also evaluates how the degree of distribution of agents, manner of their interaction and their social attitude towards each other affects the performance parameters of the system.

European Commission's Information Society Technologies - 'Shuffle' project, which uses layered architecture of agents to control and manage both business interactions and radio resources, was the source of motivation for our work.

A particular novel aspect of our work is the introduction of a new plane called 'Connection Plane' and the design of new cell level hybrid agent called 'Network Provider Cell Agent (NPCA)' as extension to the 'Shuffle' model. This agent is a layered hybrid agent, with 'Local Planning' and 'Call Establishment' layers. It has the capability
of interacting with other agents in distributed manner. This NPCA agent makes call admission and channel borrowing decision according to the policies passed by the Local Planning Layer.

Designing the interaction model for agents forms the second part of contributions. Our work proposes two Multi Agent based Service Architectures depending on the degree of distribution of agents and the type of interaction, in Connection Plane: Network Provider Resource Agent (NPRA-based) Centralized Service Architecture and Network Provider Cell Agent (NPCA-based) Distributed Service Architecture. Theses service architectures use Foundation for Intelligent Physical Agent compliant message ‘performatives’. These performatives have been modeled using open source Java Agent DEvelopment framework, JADE 3.1, from Telecom Italia labs, for the domain.

The third part of our work deals with call admission control policies of Local Planning Layer of NPCA. These policies are termed as Multi Agent based CACs (MA-CAC). The admission policies chosen are static as well as dynamic. They also cater to different classes (voice/data) of traffic and mobility patterns (high/low). Priority and non-priority handoff traffic is also considered. We analyze various MA-CACs and compare and evaluate performance of each in terms of connection level parameters such as new call blocking probability, handoff call blocking probability, effect of queue on blocking probability in multi agent based environment.

The final part of our work uses the concept of Social Welfare for channel borrowing through MAS of socially intelligent agents to handle congestion.

The work highlights the benefits of MAS for maintaining QoS for the domain of cellular network by evaluating various multi agent based call admission control strategies for different traffic conditions. It establishes the effect of degree of distribution of agents on system performance by comparing the two service architectures for reactivity, responsiveness, utilization of resources, communication overhead, sustainability, scalability, robustness and modifiability. It also establishes the relationship between the social attitude of an agent towards the other agents and fairness of resource distribution. This evaluation helps in building knowledge for choosing the correct multi agent based CAC and channel borrowing schemes, along with the most suitable service architecture for the required QoS and traffic conditions.